ADVANCED HYBRID VEHICLE CIDI ENGINE REQUIREMENTS, MAIN TECHNICAL BARRIERS AND R&D NEEDS

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The CIDI engine is a favored candidate for the energy conversion device in a PNGV hybrid electric vehicle (HEV) for the following reasons:

- High Thermal Efficiency - Peak thermal efficiencies greater than 40% have been demonstrated in production light-duty CIDI engines and the CIDI engine maintains its high efficiency over a wide operating map.
- Low Cold-Start/Restart Emissions and Rapid Restart Capability - These characteristics are particularly important in hybrid vehicle applications where the engine may be frequently stopped and started.
- Operating Flexibility - The broad torque characteristic of the CIDI engine enables its use in series-hybrid, parallel-hybrid and conventional vehicles and allows a high degree of flexibility in the vehicle operating strategy.
- Demonstrated Affordability - Though the variable cost of a CIDI engine is higher than a conventional gasoline engine, it has been demonstrated that it can be produced economically on a very large scale.
- Basic Design, Development, Manufacturing and Operating Strategies are well understood.

Significant strides have been made, particularly in Europe, in overcoming the traditional deficiencies of the CIDI engine, however, the demanding PNGV program goals and US market and legislative considerations present major challenges in the following areas.

- Exhaust Emissions - The CIDI engine emits less HC, CO and CO_2 than the port-injected, homogeneous-charge gasoline engine, however, meeting US Federal Tier II and California ULEV NOx and particulate matter (PM) standards is the most difficult challenge for the CIDI engine.
- Noise, Vibration and Harshness (NVH) - Further improvements in idle and heavy acceleration NVH are required to meet US market demands.
- Power-Density - Both displacement-specific and weight-specific power-density require improvement to be consistent with PNGV targets.
- Cost - Cost containment with advanced emissions control features and lightweight materials is a major challenge.

Intensive R&D effort is required to address these challenges.